



# **GRIC Protecting Our Communities Addressing Domestic Violence, Child Violence, and Sexual Violence**



October 14 – 18, 2019  
Phoenix, Arizona

## **DNA: HOW EVIDENCE IS ANALYZED & HOW TO INTERPRET THE RESULTS**

Presented by:

**Brittany Aguilar**

Sex Assault Casework Unit,  
Arizona Department of Public Safety &

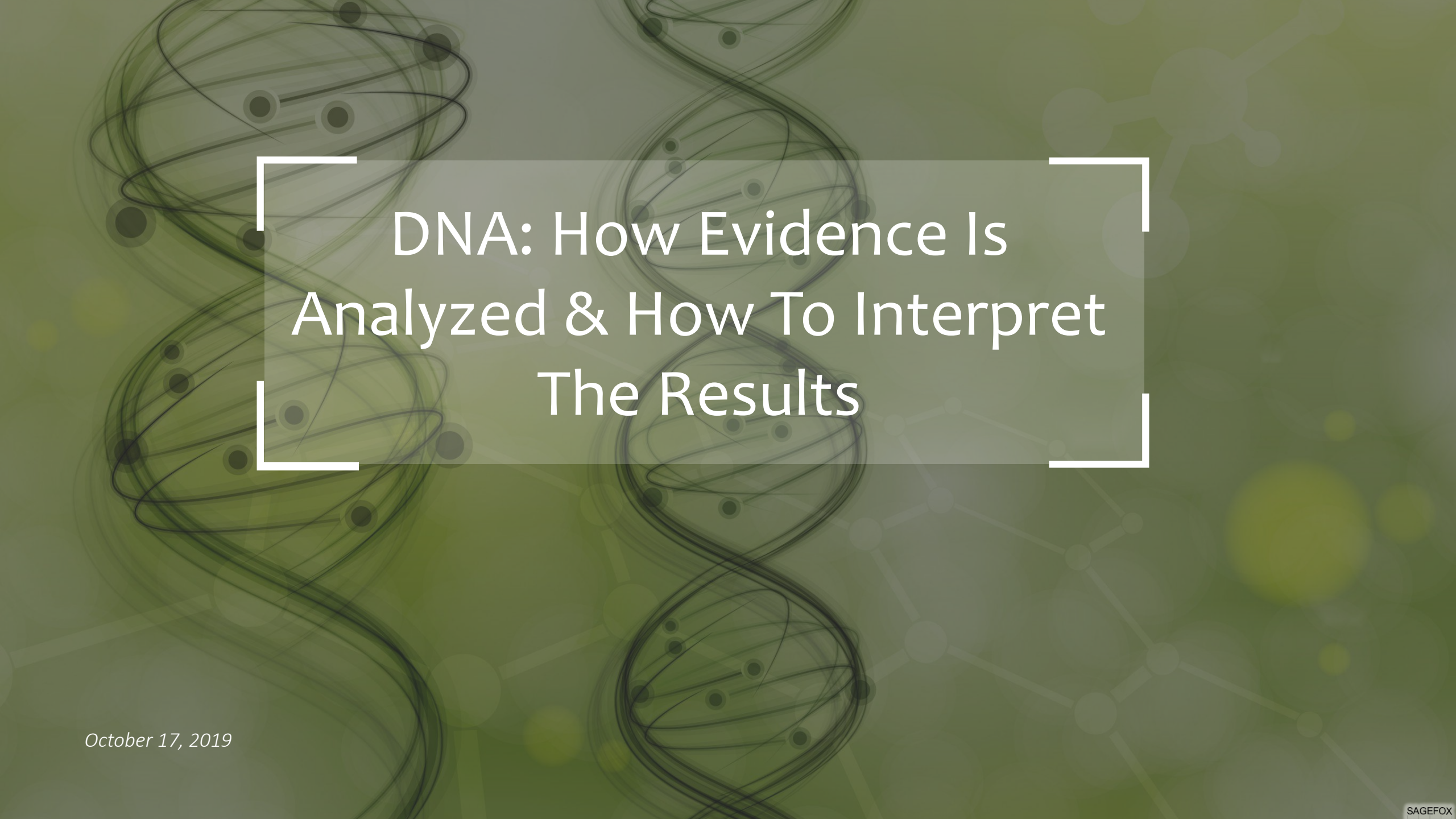
**Sarah LaFragola**

Sex Assault Casework Unit,  
Arizona Department of Public Safety

Distributed by:

ARIZONA PROSECUTING ATTORNEYS' ADVISORY COUNCIL  
1951 West Camelback Road, Suite 202  
Phoenix, Arizona 85015

ELIZABETH BURTON ORTIZ  
EXECUTIVE DIRECTOR

The background is a dark green gradient with abstract, swirling lines and dots that resemble DNA double helices and molecular structures. A large, white, stylized bracket shape frames the central text.

# DNA: How Evidence Is Analyzed & How To Interpret The Results

*October 17, 2019*

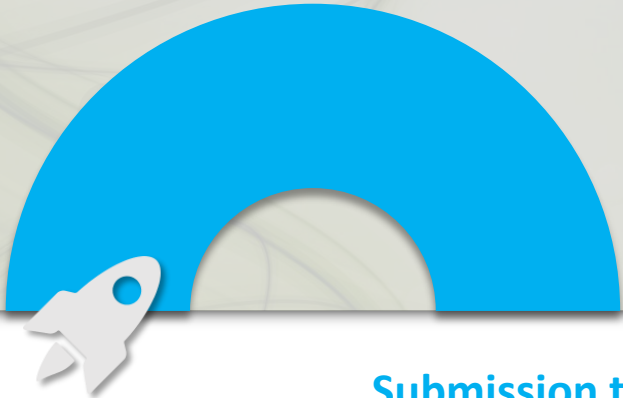
## Today's Presenters



**Sarah LaFragola**  
**Forensic Scientist**  
Sexual Assault Unit



**Brittany Aguilar**  
**Forensic Scientist**  
Sexual Assault Unit



## START

- DNA Basics

## Submission to Report

A glimpse of how  
evidence travels through  
the lab



## Serology/DNA

- Process

## Direct-to-DNA

- Process
- Reports
- Statistics

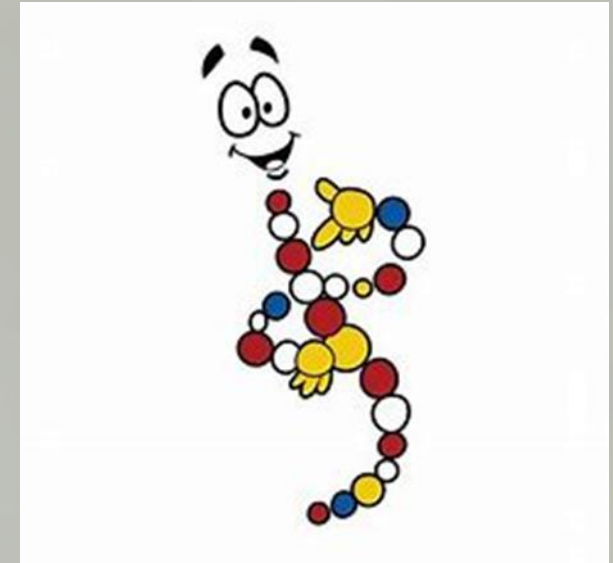
## CODIS

- Overview



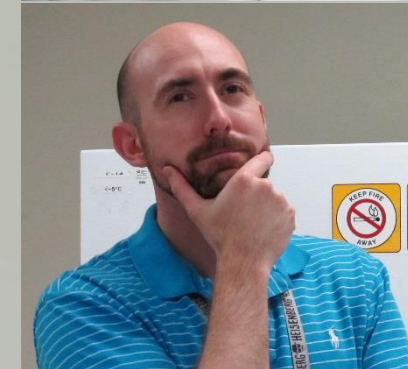
### ✓ What is DNA?

- DNA stands for Deoxyribonucleic Acid
- DNA is the genetic instructions inherited from mother and father



### ✓ What is DNA?

- Can be found in most cells in the body. Best sources of DNA are body fluids and tissues.
- DNA is unique to each individual (exception - identical siblings)

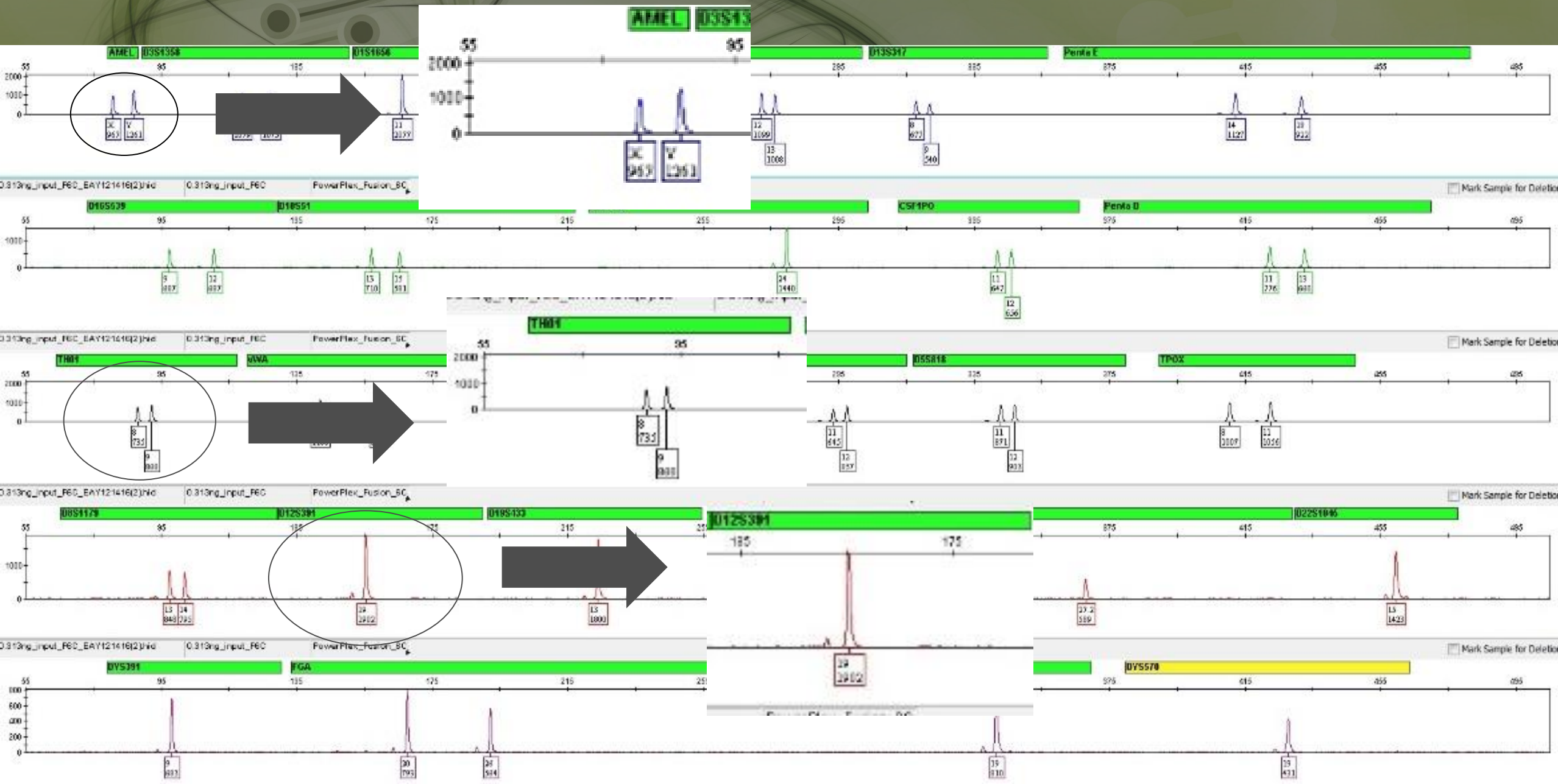


## ✓ What is a DNA profile?

- A list of numbers that represent the length of small areas of your DNA
- We look at 23 specific locations of DNA
- There are 2 numbers for each of the 23 locations (one from each parent)
- The complete list of these numbers is unique to every person

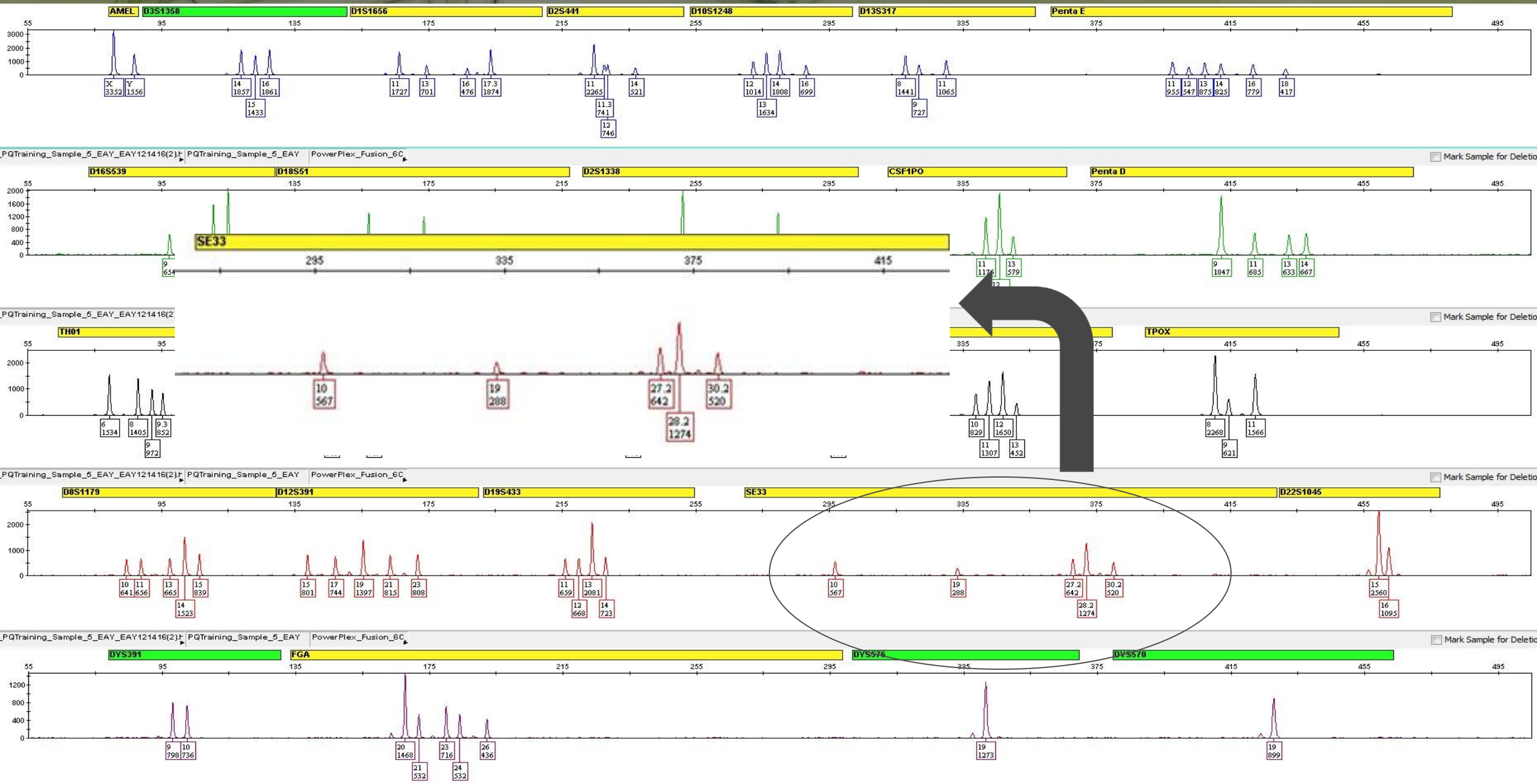
LOCUS	Crime Scene Evidence
AMEL	X,Y
D3S1358*	14,16
D1S1656	11,11
D2S441	11,12
D10S1248	12,13
D13S317*	8,9
PENTA E	14,28
D16S539*	9,12
D18S51*	13,15
D2S1338	24,24
CSF1PO*	11,12
PENTA D	11,13
TH01*	8,9
vWA*	14,18
D21S11*	22,22
D7S820*	11,12
D5S818*	7,12
TPOX*	8,12
D8S1179*	13,14
D12S391	28,28
D19S433	13,13
SE33	19,28.2
D22S1045	15,15
DYS391	9
FGA*	21,23
DYS576	19
DYS570	29
CODIS	
Comments	

## ☒ Single Contributor



# DNA Basics

## Mixture of 3 or more

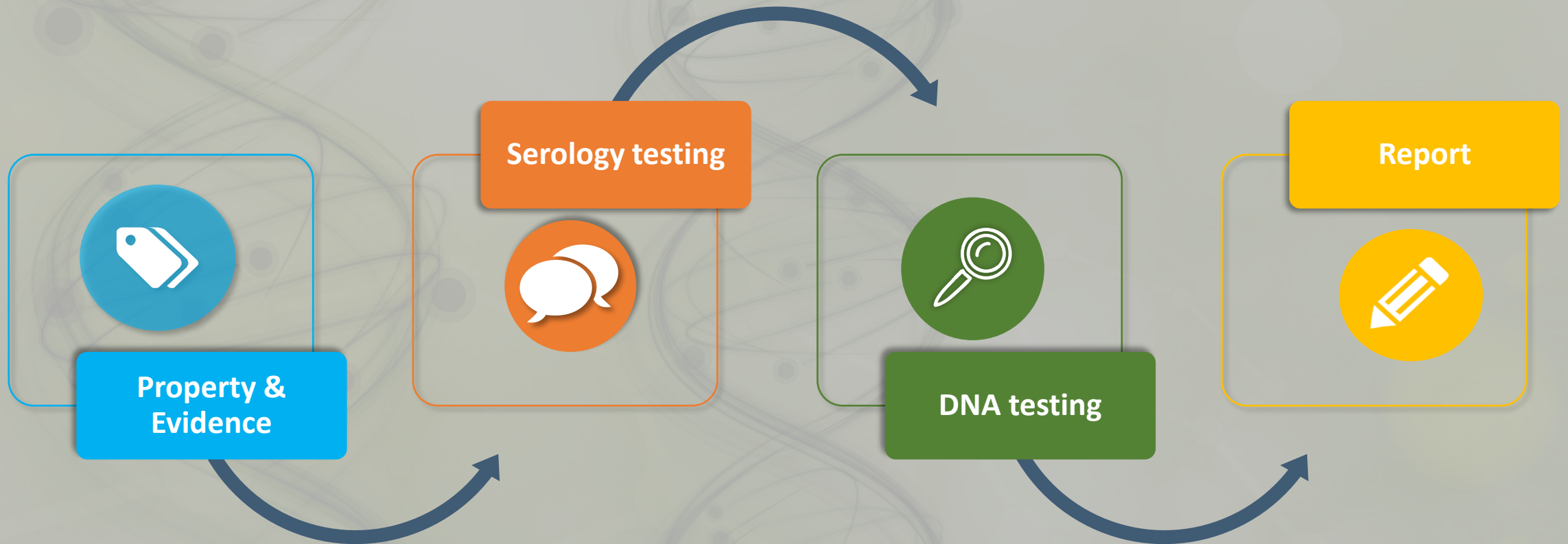


Because DNA is unique to an individual,  
it is useful in forensic investigations.

Understanding *how* DNA can help your  
investigation will help you apply this  
technology in the most effective  
manner.

### ✓ What can forensic DNA answer?

- Can help generate investigative leads in cold cases and cases without a suspect, utilizing CODIS (national database).
  - Example: DNA profile from crime scene evidence “hits” a profile already in CODIS
- Determine whether a particular DNA profile is present on an item or at a crime scene
- Identify the perpetrator of a sex crime if we develop DNA profiles from Sex Crime Evidence Kits (SCEK or SAK)
- Familial questions (ex. criminal paternity).
  - Example: Pregnancy resulting from a sexual assault or sexual contact with a minor (can test DNA from the baby or product of conception).
- Identity of an individual
  - Examples:
    - Unidentified human remains (if related to a crime)
    - Unknown identity cases (unable or unwilling to identify themselves)





## ✓ Submit it!

- All evidence is submitted to the Property & Evidence Unit (P&E).
  - Non-DPS Agencies- Evidence needing laboratory testing.
  - DPS- Evidence needing laboratory testing & storage.
- Packaging of evidence is checked
  - Only cardboard boxes and manila envelopes are accepted by P&E. Only exception are the Sex Crimes Evidence Kits (SCEKs) which are in brown paper bags.
  - Tape Seal on the outer most package
  - Please don't overpackage!
- Proper paperwork submitted with evidence
  - Completed Request sheet
  - DNA Supplemental Form





## ✓ Case Review

- Serologist is assigned to case
  - Review paperwork
    - All information needed received
    - All necessary standards received
    - Contact Detective, if necessary, to determine which samples will be moving forward
  - Obtain evidence from storage





## ✓ Screening

- Examine evidence
  - Chemical testing for items containing possible bodily fluids
    - If testing occurs, serologist will issue a report regarding the chemical testing results
    - Sample for possible trace/touch DNA
  - Samples are retained in tape sealed containers and stored in the secure DNA lab to await further DNA analysis
  - Repackage evidence in original packaging and return to P&E to be returned back to the agency.





## ✓ Casefile Review

- DNA Analyst assigned to case
  - Review paperwork
    - All information needed received
    - All necessary standards received
  - Obtain evidence from storage



## ✓ Extraction

- Get the DNA out & clean it!
  - Chemicals are added to the samples & heated to break open the cells to attain the DNA.
  - The samples are then treated with additional chemicals or processed on an instrument to clean the DNA by separating it from any broken pieces of the cells.
  - The clean DNA is suspended in a liquid & is called the **extract**.





## Quantification

- Count it!
  - A small sample of the extract (DNA) is added to chemicals & put on an instrument that estimates the amount of human and male concentrations.
  - These quantities are evaluated and can dictate what samples will have further DNA analysis based on which ones have the best chance of producing results.
  - The concentrations determine which kit, STR vs. Y-STR, are used to develop a profile.
    - Will be discussed later in presentation...





## ✓ Amplification

- Copy it!
  - Multiple copies of the specific locations are made and tagged with a color (blue, green, yellow, red, purple).





## ✓ Interpretation

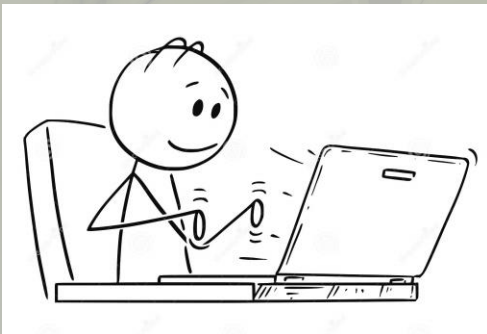
- Figure it out!
  - The copied samples are then run on an instrument that detects what profile is in the sample.
  - The profile is reviewed and interpreted by the DNA analyst.
    - The resulting profile may then be entered into the Combined DNA Index System (CODIS) to be searched for a match if eligible.
    - The resulting profile may be compared to any individuals whose DNA reference sample was submitted to the lab.

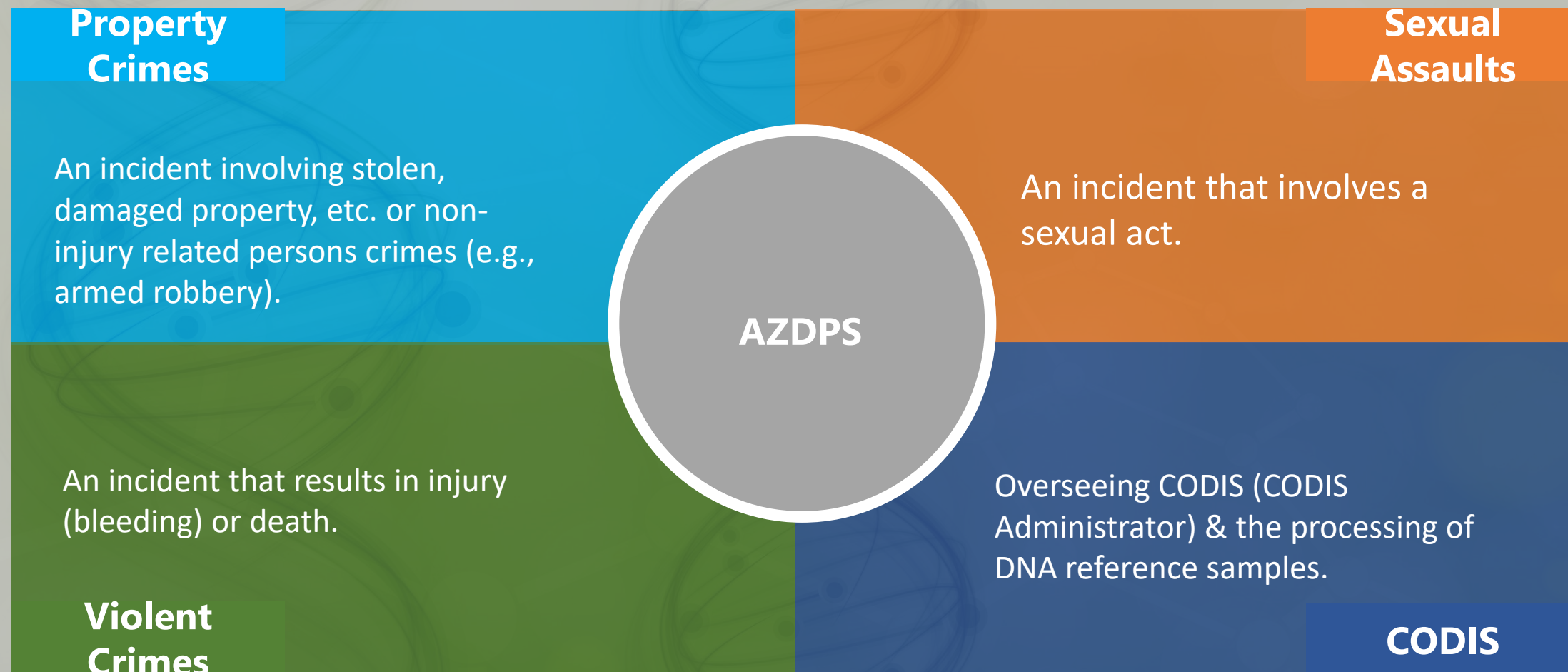




## ✓ Report it

- Tell you what we got!
  - It is our lab's policy that we include all results on our official reports, so you may see a variety of conclusions.
    - You will see a statement for:
      - The presence or absence of male DNA on any samples that were not selected for testing (mainly for sex assault cases).
      - What kits were used on the samples for DNA testing.
      - Any conclusions obtained.
      - What we retained.
      - If further work will be done.
      - Anything we may need from you.

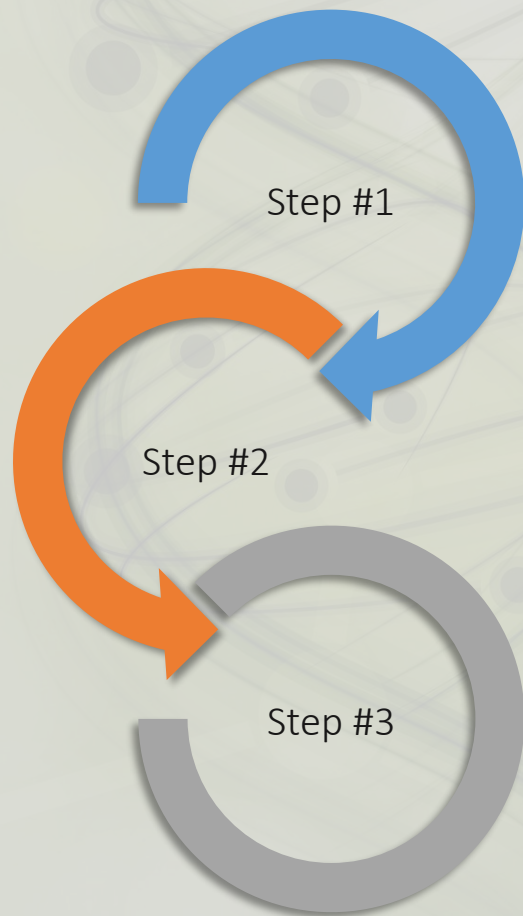






Direct-to-DNA  
April 2018

# Direct-to-DNA



## Step #1

Up to 3 samples from the SCEK are selected/prepped by the serologist based on case history or other case circumstances (i.e. consensual sex partner, multiple assailants, etc.) for immediate DNA testing. If unknown circumstances, a portion of all samples are prepped.

## Step #2

DNA analysis is performed to determine if useable results and/or a CODIS profile is obtained.

## Step #3

Issue report and proceed with additional testing if necessary.



## Step #1

Step #1

Up to 3 samples are selected/prepped by the serologist for Direct-to-DNA from the SCEK based on the case history provided (i.e. consensual sex partner, multiple assailants, etc.).

- Exceptions to the number of samples are dependent on case circumstances.
  - If circumstances are unknown all samples are prepped
- Once selected, no more than half of each sample is placed in a tube for DNA testing.
  - If circumstances dictate that more than half of the sample is needed, then the Detective and/or County Attorney will be contacted for Permission to Consume if a suspect is listed.
  - If no response is received within 15 business days, then the samples will be prepped to maximize the potential for the sample.
- Remaining swabs & the vaginal aspirate are retained at the laboratory.



Step #2

Step #2

DNA analysis is performed to determine if useable results and/or a CODIS profile is obtained.

- Extraction- Get the DNA out & Clean it!
  - All samples suspected to have possible semen are subjected to a differential extraction process that separates all sperm cell DNA from the remaining DNA present (i.e. skin cells).
    - Epithelial Fraction- DNA from possible skin cells
    - Sperm Fraction- DNA from possible sperm
- All saliva, touch or samples not indicated to have semen are subjected to a routine extraction process.



Step #2

Continued...

- Quantification- Count it!
  - Human and male concentrations are determined.
  - The concentrations are evaluated, and the samples with the best chance of producing results are selected for further DNA testing.
    - If a sample was not selected for testing it is because another sample had more male DNA or the amount of male DNA is insufficient to obtain a DNA profile to be entered into CODIS.
  - The concentrations determine which kit, STR vs. Y-STR, are used to develop a profile.
    - STR- traditional kit used to develop unique DNA profiles. Has potential to be highly discriminatory.
    - Y-STR- kit used to develop less unique, Y-profiles that are the same for males among a paternal line. Less discriminatory than traditional STR.

### STR (Short Tandem Repeat) testing

What most people think of when talking about “DNA testing”

Inherited equally from mother and father

Unique to all individuals except identical siblings

### Y-STR testing

Male DNA testing

Paternal line males have the same Y-STR type = lower discriminating power

(i.e. Grandfather, father, son, brother, uncle, male cousin...generally same last name = same Y-STR type)

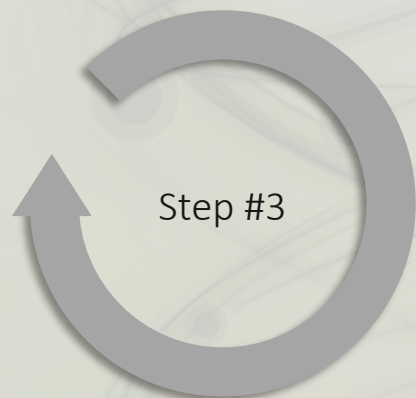
Useful in sexual assault cases or evidence with very low amounts of male DNA present



Step #2

Continued...

- Amplification- Make Copies!
- Interpretation- Figure out what you got!
- Reporting- Tell you what we got!



### Step #3

Test additional evidence if necessary.

- Cases in which a probative result is not achieved will be evaluated for further testing.
  - Additional samples in the kit?
  - Supplemental evidence submitted?
- Cases that have multiple perpetrators that haven't been identified
- Look for "Further DNA testing will be performed on the remaining items from the sexual assault kit" on the report.

## Reports



Let's take a closer look...



## Serology

- Analyzes for possible blood, semen, saliva, touch DNA, etc.
  - All tests and results are listed on report
    - Blood
    - Semen
    - Saliva
- Samples retained in the lab are listed on report
- A report will be issued to submitting Detective/Officer

**In most cases action from submitting agency will be required (standards needed, permission to consume needed, etc).**



## ARIZONA DEPARTMENT OF PUBLIC SAFETY

### SCIENTIFIC EXAMINATION REPORT

TEST7

Page 1 of 1

AGENCY Tempe Police Department  
Tempe, AZ 85281  
AGENCY NO. TEST  
OFFICER ORR, #15301  
DATE September 12, 2019  
NAME(S) PERSON, GUY



#### EXAMINATION REQUESTED

Serology

#### RESULTS / INTERPRETATIONS

		Blood	Saliva	Semen	Sperm
EV195567.A.	One knife	Pos.	Not Tested	Not Tested	Not Tested
EV195569.A.	One swab from kitchen floor	Not Tested	Neg.	Not Tested	Not Tested
EV195569.B.	One swab from kitchen floor	Not Tested	Not Tested	Inc.	1 Sperm
EV195569.C.	One swab from kitchen floor	Inc.	Sheep	Not Tested	Not Tested

#### ACTION ITEM(S)

A buccal sample from the suspect is still needed for DNA comparison.

#### NOTES

- The results for blood are from preliminary testing.
- The results for saliva are from a preliminary test based on the presence of amylase. Amylase is a constituent of saliva and may be found in other body fluids.
- The results for semen are from preliminary tests based on the presence of either Acid Phosphatase (AP) and/or Prostate Specific Antigen (PSA). These are both constituents of semen and may be found in other body fluids.
- Inconclusive results for blood and semen are due to limited sample. Inconclusive results for spermatozoa are due to physical characteristics.
- Portions of all items referenced above have been retained in laboratory storage. All other items received were not analyzed.

GRANT BELANCIK, #7200, Forensic Scientist  
Central Regional Crime Laboratory  
2102 W. Encanto Blvd., Phoenix, AZ 85009  
602-223-2848 gbelancik@azdps.gov



## DNA

- Male detected, not detected or low level
- Kits used for DNA Analysis
- Conclusions/comparisons to standards/statistics (if needed) for each sample
- CODIS entries (if any)
- What was retained in the lab
- If any further standards needed and/or if further testing will be done
- A report will be issued to submitting Detective/Officer

**Make sure to read the entire report (they are typically more than 1 page of results)**



## ARIZONA DEPARTMENT OF PUBLIC SAFETY

### SCIENTIFIC EXAMINATION REPORT

TEST7

Page 1 of 2



AGENCY Arizona Department of Public Safety

AGENCY NO. TEST  
OFFICER ABDULLAH, JR., #6827  
DATE September 30, 2019  
NAME(S) LOYA, ADAN

#### EXAMINATION REQUESTED

DNA

#### RESULTS/INTERPRETATIONS

		Male DNA
EV186228.	One buccal swab from Adan Loya	Detected
An STR and Y-STR DNA profile was obtained and entered into CODIS.		
EV186368.	Sex Crime Evidence Kit from Jackelyn Soto containing:	
EV186368.3.	Two buccal swabs from Jackelyn Soto	Not Detected
An STR DNA profile was obtained.		
EV186368.6.	Two anal swabs	Detected
The DNA profile from the sperm fraction is a mixture consistent with the combined DNA profiles from item 1.3 (Jackelyn Soto) and item 100 (Adan Loya) at 7 STR loci. It is 5.7 billion times more likely to observe this mixed DNA profile if item 1.3 (Jackelyn Soto) and item 100 (Adan Loya) are the contributors than if item 1.3 (Jackelyn Soto) and a random, unrelated African American are the contributors; 570 million times more likely than if item 1.3 (Jackelyn Soto) and a random, unrelated Caucasian are the contributors and 11 billion times more likely than if item 1.3 (Jackelyn Soto) and a random, unrelated Hispanic are the contributors. Item 100 (Adan Loya) cannot be excluded from the mixture at the remaining 16 STR loci.		

GRANT BELANCIK, #7200, Forensic Scientist  
Central Regional Crime Laboratory  
2102 W. Encanto Blvd., Phoenix, AZ 85009  
602-223-2848 gbelancik@azdps.gov

Accredited by the ANSI National Accreditation Board (ANAB) to International Standards

Any notes, photographs, charts, or graphs generated during the examination are retained in the laboratory. Unless otherwise denoted, all evidence will be returned to the submitting agency. For additional information regarding laboratory policies visit [www.azdps.gov/crimelab](http://www.azdps.gov/crimelab)



MAS

DR NO:

Page 1 of 3



AGENCY

AGENCY NO.

OFFICER

DATE August 20, 2019

NAME(S)

EXAMINATION REQUESTED

DNA

ITEMS

- 101. Sex Crime Evidence Kit from
- 101.2. Two oral swabs
- 101.3. Two buccal swabs from
- 101.4A. Two circumoral swabs
- 101.4B. Two right palm/finger swabs
- 101.8A. Two external genital glans swabs
- 101.8B. Two external genital shaft swabs
- 101.8C. Two external genital scrotum swabs
- 200. Two buccal swabs from

RESULTS / INTERPRETATIONS

Male DNA was detected on the epithelial fraction of item 101.4A and the sperm fractions of items 101.8A and 101.8B; however, no further testing was done on these items at this time.

Items 101.3, 200, the sperm fraction of item 101.4A and the epithelial fractions of items 101.8A and 101.8B were analyzed using the PowerPlex Fusion 6C PCR Amplification Kit. Furthermore, items 101.3 and 200 were analyzed using the PowerPlex Y23 PCR Amplification Kit.

The DNA profile from the sperm fraction of item 101.4A (circumoral swabs) is a mixture consistent with the combined

*Sarah Lafragola*

SARAH LAFRAGOLA, #7517, Forensic Scientist  
Central Regional Crime Laboratory  
2102 W. Encanto Blvd., Phoenix, AZ 85009  
602-223-2668

# Reports



## Likelihood Ratio

- Given the evidence, it compares 2 possible explanations to one another, the statistic reflects how much more likely one explanation is over the other in each sub-population (African American, Caucasian, Hispanic and Navajo/Apache if needed)
- Example:
  - Victim + Suspect vs. Victim + Unknown



## ARIZONA DEPARTMENT OF PUBLIC SAFETY SCIENTIFIC EXAMINATION REPORT

DR NO.  
Page 2 of 3

DNA profiles from item 101.3 and item 200 } at 13 loci. It is 340 times more likely to observe this mixed DNA profile if item 101.3 and item 200 are the contributors than if item 101.3 and a random, unrelated African American are the contributors; 8.2 sextillion times more likely than if item 101.3 and a random, unrelated Caucasian are the contributors and 160 quintillion times more likely than if item 101.3 and a random, unrelated Hispanic are the contributors. Items 101.3 and 200 cannot be excluded at the remaining 10 loci.

The DNA profile from the epithelial fraction of item 101.8A (glans swabs) is a mixture consistent with the combined DNA profiles from item 101.3 and item 200 } at 4 loci. It is 59 million times more likely to observe this mixed DNA profile if item 101.3 and item 200 are the contributors than if item 101.3 and a random, unrelated African American are the contributors; 32 million times more likely than if item 101.3 and a random, unrelated Caucasian are the contributors and 150 million times more likely than if item 101.3 and a random, unrelated Hispanic are the contributors. Items 101.3 and 200 cannot be excluded at the remaining 19 loci.

The DNA profile from the epithelial fraction of item 101.8B (shaft swabs) is a mixture. The major component of this mixture matches the DNA profile from item 200 at all 23 STR loci. The approximate incidence of this profile is 1 in 330 decillion African Americans, 1 in 170 decillion Caucasians and 1 in 510 nonillion Hispanics. The minor component of this mixture is consistent with the DNA profile from item 101.3

The DNA profile from item 200 and the major DNA profile from the epithelial fraction of item 101.8B (shaft swabs) have been entered into CODIS. CODIS searches will be routinely performed and any future matches will be reported.

Portions of all items listed above have been retained in laboratory storage.

Item 101.12 (underwear bag) was received but not analyzed.

(1 million = 1,000,000  
1 quintillion = 1,000,000,000,000,000,000)

*Sarah LaFragola*

SARAH LAFRAGOLA, #7517, Forensic Scientist  
Central Regional Crime Laboratory  
2102 W. Encanto Blvd., Phoenix, AZ 85009  
602-223-2668

Accredited by the ANSI National Accreditation Board (ANAB) to International Standards  
Any notes, photographs, charts, or graphs generated during the examination are retained in the laboratory.  
Unless otherwise denoted, all evidence will be returned to the submitting agency.

## Random Match Probability

- This statistic shows how frequently we would expect to observe this profile in each sub-population (African American, Caucasian, Hispanic and Navajo/Apache if needed)

Both statistics are based on the estimated rarity of the DNA profile, not the strength of the match

# Reports



## ARIZONA DEPARTMENT OF PUBLIC SAFETY SCIENTIFIC EXAMINATION REPORT

DR NO.  
Page 3 of 3

1 sextillion = 1,000,000,000,000,000,000  
1 nonillion = 1,000,000,000,000,000,000,000,000,000,000  
1 decillion = 1,000,000,000,000,000,000,000,000,000,000,000

*Sarah LaFragola*

SARAH LAFRAGOLA, #7517, Forensic Scientist  
Central Regional Crime Laboratory  
2102 W. Encanto Blvd., Phoenix, AZ 85009  
602-223-2668

Accredited by the ANIST National Accreditation Board (ANAB) to International Standards  
Any notes, photographs, charts, or graphs generated during the examination are retained in the laboratory.  
Unless otherwise denoted, all evidence will be returned to the submitting agency.

TML  
MHS

CODIS



## Overview

✓ CODIS – National DNA Database

Combined DNA Index System

Useful for generating a suspect  
Useful for linking suspects and/or cases  
nationwide.



## ✓ CODIS – National DNA Database

Not all DNA profiles that we get from evidence are eligible to enter into CODIS.

CODIS is managed by the FBI and we must follow their rules.

## ✓ CODIS Eligibility

Questions we *must* answer about the evidence in order to use CODIS:

- Was a crime committed?
- Where was the evidence collected from within the crime scene?
- Was the DNA on the evidence likely left by the perpetrator of the crime (not a victim or other person)?
- Was the evidence seized or collected directly from a suspect's possession? (Not CODIS eligible)



## Reasons a profile may not be CODIS eligible:

- Elimination standards were not received
- The evidence did not meet CODIS eligibility requirements
- We were not able to obtain a DNA profile or not enough of a profile to meet CODIS rules
- Complicated mixture

The End!

Questions?



Grant Belancik  
Sexual Assault DNA  
Supervisor

Contact info:  
[gbelancik@azdps.gov](mailto:gbelancik@azdps.gov)  
(602) 223-2848